E2201 Aug 3:0

Information theory

Instructor

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Department: Electrical Communication Engineering

Course Time:

Lecture venue:

Detailed Course Page: http://www.ece.iisc.ernet.in/~htyagi/course-E2201-2016.html

Announcements

Brief description of the course

This is a graduate level introductory course in Information Theory and will be a prerequisite for many advanced courses. Information Theory is the science for measuring, preserving, transmitting, and estimating information in random data. It was initially proposed by Shannon as a mathematical theory of communication more than five decades ago. It provides the fundamental limits of performance for transmission of messages generated by a random source over a noisy communication channel. On the one hand, Information Theory has been the driving force behind the revolution in digital communication and has led to various practical data compression and error correcting codes that meet the fundamental theoretical limits of performance. On the other hand, over the years, techniques and concepts from Information Theory have found applications well beyond communication theory. In this course, we will introduce the basic notions and results of Information Theory, keeping in mind both its fundamental role in communication theory and its varied applications beyond communication theory. This course, and the follow-up advanced courses to be offered in the future, will be of interest to students from various backgrounds.

Prerequisites

The course requires familiarity with basic probability and general mathematical maturity. However, it is self-contained. Any first year graduate student with a UG degree in Electrical Engineering, Computer Science, Physics, or Mathematics can take the course.

Syllabus

1.Compression of random data: fixed and variable length source coding theorems and entropy

2.Hypothesis testing: Stein's lemma and Kullback-Leibler divergence

3. Measures of randomness: Properties of Shannon entropy, Kullback-Leibler 4.divergence, and Mutual Information

5.Transmission over a noisy channel: channel coding theorems, joint source-6.channel coding theorem, the Gaussian channel

7.Lower bounds on minimax cost in parameter estimation using Fano's inequality

8. Quantisation and lossy compression: rate-distortion theorem

Course outcomes

The student is expected to understand the definitions of various measures of information and have a working knowledge of their properties. Furthermore, the student should be able to formalize compression, transmission, and estimation problem in an information theoretic setting. The course will also teach the student how to show the optimality of codes for compression and transmission. Finally, advanced students will develop heuristics for identifying packing and covering problems in many standard information processing scenarios.

Grading policy

Homework: 20%; Mid-term 1: 20%; Mid-term 2: 20%; Final exam: 40%

Assignments

Resources

1.T. Cover and J. Thomas, Elements of Information Theory, Second edition, Wiley, 2006.
2.I. CsiszÃ r and J. KÃ¶rner, Information Theory: Coding Theorems for Discrete Memoryless Systems, Second edition, Cambridge, 2011.

3.J. Wolfowitz, Coding Theorems of Information Theory, Probability Theory and Stochastic Processes series, Springer, 1978.
4.A. Khinchin, Mathematical foundations of information theory, Dover, 2001 edition.
5.A. Feinstein, Foundations of Information Theory, McGraw-Hill, 1958.
6.T. S. Han, Information spectrum methods in Information Theory, Stochastic Modeling and Applied Probability series, Springer, 2003.
7.R. G. Gallager, Information Theory and Reliable Communication, Wiley, 1969.